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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Edwin Young Call	
Serial No.:	10/089,315	Group Art Unit: TBA
Filed:	March 29, 2002	Examiner: TBA
For:	System For Protection Of Submerged Marine Surfaces	

DECLARATION OF EDWIN Y. CALL

NOW COMES Edwin Y. Call, inventor in the above-identified application and hereby declares and states as follows:

I am aware of the International Search Report dated August 2, 2001 that has issued in the national phase of my PCT Application No. PTC/US01/13924 and have studied and carefully considered the three references cited therein, namely, *Littauer* U.S. 3,497,434, *Kaiser* et al. U.S. 4,992,337 and the Japanese reference 61-124679. I am also aware of and have studied the written opinion dated April 2, 2002, and the International Preliminary Examination Report of August 14, 2002 and the additional cited reference of *Champagne* U.S. 4,915,906.

Briefly summarized, my invention provides a system for the protection of surfaces that are subjected to a submerged marine environment. As described in the application, particularly on page 1, beginning at line 10, the invention resolves the design requirements to prevent bio-fouling of submerged marine structures, to provide barrier corrosion protection and simultaneously provide cathodic protection to metal parts. Moreover, my invention is also successful for use on moving parts such as propellers. The invention differs from the cited patents and explanations because my invention is multi-functional providing bio-fouling

protection, barrier corrosion protection, and cathodic protection without the need to externally induce an electrical current.

These three aspects of my invention are described in detail in the present application. Relevant to the first aspect of my invention, attention is invited to the article entitled "Marine Fouling and Coatings for its Control" by Clive H. Hare (published in Journal of Protective Coatings and Linings, June 2000). Dr. Hare lists the common methods for controlling fouling as:

(1) Coating the structure with a toxic film;

(2) Applying a coating with a leaching agent;

(3) Applying a coating that works through the dissolution of a toxic agent;

(4) Applying an ablative coating that sloughs off along with the fouling and new layers of coating are exposed; and

(5) Applying a coating with a foul release system that inhibits adhesion of fouling.

In short, one or more of these methods must be used to create an effective antifouling coating. For metallized coatings in a submerged marine environment, the effectiveness also depends on the composition of the metal coating, the reaction of the coating with the metal substrate, the reaction to additional nearby metals, the thickness, the performance on moving and non-moving structures, and the surface texture. Therefore, a complex interrelationship of many conditions makes it very difficult to predict the success or failure of any particular type of metallic coating when used on a metal substrate in a submerged marine environment. Many prior art systems may address some of these problems but not all of them.

To understand the present invention requires having knowledge of the fact that the environment of submerged marine structures inflicts unique corrosive conditions on metallic systems. The present invention as described in the application is a metal coating applied over a variety of surfaces, particularly metal as well as fiberglass, plastic, composites, concrete and wood. The present invention is applied to surfaces that will be submerged in a severe marine environment. In carrying out the present invention, the system of this application enables the coating of metal on, for example, a metallic substrate to form a compatible metallic coating system. Because of the flexibility of the process described in the application, the coating can be applied to a structure that has a combination of surfaces such as metal and fiberglass or plastics, or composites, concrete and/or wood. If the substrate is metal, the present invention will protect the submerged surface from bio-fouling and corrosion. If the surface is not metal, the substrate will be protected from bio-fouling.

Recognized authorities have attested to the corrosive nature of marine environments. For example, Dr. R.W. Staehle states in his book, Uhlig's Corrosion Handbook, that ". . .environments to which materials are exposed dominate considerations in predicting and assuring their reliable performance". (See Uhlig's Corrosion Handbook, New York: John Wiley & Sons, Inc., editor R. Winston Revie, 2000, page 45-46.) Listed by Dr. Staehle in the book are the components of the environment that affect degradation of metal; namely: the chemical composition of the environment, the electrochemical composition, microbiological species, surface alterations, flow, phase, temperature, stress, relative motion of adjacent surfaces, neutron flux, electromagnetic radiations and charged particles. As can be seen from the list of environmental conditions that affect corrosion as explained by Dr.Staehle, the matter of

achieving adequate and satisfactory protection is not a simple matter of merely coating a surface with one material, with the expectation that satisfactory and compatible results would be obtained. The problem of corrosion has existed for thousands of years and people involved with this technology are still endeavoring to perfect systems of control or prevention for specific applications. The invention in my application resolves problems particularly associated with the anti-fouling and corrosion protection of metallic systems in submerged marine environments.

In Uhlig's Corrosion Handbook, Dr. E.D. Verink, Jr. further explains that it is important to make a proper design choice to prevent corrosion. In addition, one must be careful not to introduce corrosion by making an improper design choice. Included among such design choices for a metal coating are the selection of the metal alloy coating, the condition of stray currents, and selective loss of one or more ingredients of an alloy. These choices and six others affect the corrosion of metallic systems. (See page 97.) These design considerations are especially critical to the performance of metallic protective coatings for metal components and structures as explained in my application. The corrosion rate is also an important consideration for systems that are present in a submerged marine environment. For example, Dr. Verink states in his chapter on the protection of metals from corrosion that the corrosion rate of metals in sea water varies depending upon salinity, dissolved oxygen concentration, temperature, pH, carbonate content, the presence of pollutants and the presence of biological organisms. (See page 545.)

My invention enables the protection of a variety of metals including carbon steel, aluminum, stainless steel, brass, copper, copper-nickel, monel, lead and bronze. As can be immediately seen from the foregoing lists, the properties of each of these metals is quite unique

and therefore the problem of providing corrosion protection for this list of various metals is unique compared to the patents cited in the International Preliminary Examination Report. For example, *Littauer* discusses only protecting steel from fouling and *Kuraray* makes no mention of protection of metal from corrosion or any kind of cathodic protection but is limited entirely to the treatment of textiles to prevent bio-fouling. The *Champagne* Patent mentions no particular surface and especially not a severe marine environment.

As further evidence of the knowledge of the industry, in an article on the design of foul release coatings, M. Candries stresses the importance of reducing drag which he defines as "the resistance of water to the ships passage through it." (See "Foul Release Systems and Drag" JPCL, April 2001.) The author states that the "smoothness of the surface of the hull will minimize drag and will therefore also reduce fuel consumption (and pollution)". My invention produces a smooth and dense coating which therefore accomplishes the reduction of drag for a ship passing through the water.

The Japanese document 61-124679 (Kuraray) relied on in the International Preliminary Examination Report discloses a system of flame spraying a zinc-aluminum alloy on a textile in order to reduce the adherence of aquatic organisms. Textile materials disclosed by *Kuraray* includes net, string, rope, sheets and baskets typically used as fishing equipment which is treated in order to prevent adherence of marine and aquatic organisms. The *Kuraray* document does not address the problem of corrosion. There was no need for *Kuraray* to even consider any of the conditions outlined in the Revie corrosion handbook which would affect the corrosion of surfaces, particularly metals in a submerged marine environment. As a person with years of experience in the boat maintenance business, I would not have considered the *Kuraray*

document to provide any clues for solving corrosion problems, particularly on metal surfaces. In summary and in fact, zinc aluminum coatings on metallic substrates in a submerged marine environment can introduce and cause accelerated corrosion.

In addition, the flame spray process referenced in *Kuraray* is 1) slow and therefore uneconomical, and 2) the relatively low tensile bond strength produced by flame spray produces a low quality coating which would not be particularly well suited for severe marine environments.

In the International Preliminary Examination Report, it was stated that the Japanese reference (Kuraray) would also provide cathodic protection. However, there is no reference to cathodic protection in the *Kuraray* abstract. There would be no need for *Kuraray* to consider such issues as galvanic corrosion, stray current corrosion and the other conditions listed by Dr. Verink in the Handbook of Corrosion when considering a coating formulation to coat textiles such as a fishnet. It cannot therefore be assumed, expected or anticipated that Kuraray's coating would provide cathodic protection. The system of *Kuraray* for coating a textile fiber or fabric such as a fishnet or rope or similar surface, cannot be assumed to be suitable for cathodic protection. For cathodic protection to exist, there must be presence of dissimilar metals immersed in an electrolyte. When I as a person skilled in this technology read the *Kuraray* abstract, I would not expect that it would provide successful cathodic protection. As stated earlier, it is possible that the zinc-aluminum alloys as disclosed by *Kuraray* would increase corrosion on the metal surfaces that are contemplated and disclosed in my patent application.

Based on the unique behavior of metallic systems and based on my experience in the industry, I can say that the Japanese reference would not lead me to anticipate or to expect

that the systems for bio-fouling disclosed in the reference would enable the protection of a metallic surface against bio-fouling in a submerged marine environment.

The patent of *Littauer* , U.S. 3,497,434 (issued in 1970) discloses dissolving toxic metals via electrically energizing the metallic coating in seawater to prevent marine fouling. The *Littauer* invention cites two different coatings, a cadmium alloy and a zinc alloy. It is important to note that using an external power source to dissolve a high percentage of cadmium as claimed in *Littauer* would not be permitted today due to stringent environmental laws. Cadmium is an extremely toxic material and is considered to be a serious health risk to humans and a serious environmental risk.

Unlike *Littauer* , no external power source is required to operate my system. Two methods for cathodic protection are used in the industry: (1) impressed current method and (2) sacrificial anode method. In the corrosion control textbook "Corrosion", the authors describe these two methods. In the impressed current systems, the "power source drives positive current from the impressed current electrode through the corrosive solution and onto the structure. The structure is thereby cathodically polarized (its potential is lowered) and the positive current returns through the circuit to the power supply." (See "Corrosion" edited by Shrier, Jarman and Burstein, volume 2, Chapter 10.) Impressed current systems are expensive to install and maintain. The authors go on to explain that the sacrificial anode method is the use of the natural potential difference that exists between the structure and the second metal in the same environment to provide a driving voltage. No power source is employed when using sacrificial anodes, and this method of cathodic protection is relatively inexpensive.

The reference relied on by the examiner in the International Preliminary Examination Report, namely *Littauer* , requires the adjustment of potential of the impressed current system. It is the feature of my invention that no external power source is required and no adjustments are necessary. Therefore, my invention is more practical and less expensive to install and maintain.

Unlike the invention in *Littauer* which wants to dissolve zinc and prevent the oxide layer from building up, in my invention we want a slight zinc oxide layer to develop. *Littauer* states the oxide layer prevents the dissolution of zinc and so he uses an impressed current system to dissolve the zinc and prevent the oxide layer from building up. It is my discovery that the oxide layer helps to provide bio-fouling protection to the structure and also improves the corrosion protection. This would be contrary to the expectations of persons upon reading the *Littauer* Patent.

In addition, based on my experience, the life of the *Littauer* coating would be too short to be beneficial. The external electrical power would accelerate the consumption of the coating, especially since the coating is used in a submerged marine environment. As the consumption accelerates and the coating is depleted, it fails to provide barrier protection from the seawater and no longer provides the substrate with corrosion protection. In addition, the cathodic protection properties are substantially reduced. As a result, the *Littauer* invention would not meet basic industry requirements for the longevity of antifouling coating systems. In short, the *Littauer* invention would not be effective in preventing corrosion or fouling for extended periods.

The *Kaiser* patent (U.S. 4,992,337) uses inert gas as the atomizing propellant in lieu of compressed air. This is a practice that has been well understood and used in the thermal spray industry for over 25 years. It is well known that the use of inert gasses as the atomizing propellant reduces the oxide content and therefore increases the deposit efficiency in the resulting coating. While this is beneficial for some coating applications, it is not necessarily beneficial for other applications. The *Kaiser* patent also states that these benefits are marginal at the usual spray pressures between 45-70 psig. *Kaiser* only achieves his defined deposit efficiency benefits at 25 psig or below.

The *Kaiser* patent is another illustration of the fact that what is good in some thermal spray applications is not necessarily good in others. For example, spraying very reactive metals with inert gas will produce very pure and soft coatings, especially in the case of zinc. Coatings for submerged marine environments must be very tough and durable. Using inert gas, we metallized two propellers in May of 2001. In less than two months the coating prematurely failed; therefore a zinc thermal spray coating applied using inert gas was too soft and failed in the harsh marine environment.

Our patent application and the *Kaiser* patent are at completely different ends of the spectrum in terms of the effect of the coating we are producing. Nothing in the *Kaiser* patent would lead me to believe that the use of an inert gas at low spray pressures would benefit our application.

Other prior art is known to teach various systems for protection against corrosion. The reference of *Champagne et al.*, U.S. 4,915,906 cited in the International Preliminary Examination Report discloses thermal sprayed coatings that are said to have improved corrosion

resistance and adherence. The invention described in the *Champagne* patent is specifically for the manufacture of a powder that is then used for a plasma spray process. *Champagne*'s invention is primarily for creating a high-bond strength coating. My invention uses a coating which is applied by an electric-arc spray, not plasma spray. Moreover, my coating does not require a bond-coat to help adhesion. While the *Champagne* patent states that the coating can be used by itself without additional coatings on top, this is for atmospheric conditions on small machine element parts (primarily for internal jet engine components) and not for submerged marine environments to provide anti-fouling and corrosion resistant properties.

As a plasma process, the *Champagne* invention is only practical for low-volume, high cost parts with precise metallurgical requirements. The application process is complex, and it is extremely expensive. My invention is designed for high-volume production, the application process is simpler, and the process is economical. The plasma spray technique is routinely used in the aerospace industry where price is often not an important factor. However, in the boat building and maintenance business, coating services that provide anti-fouling or anti-corrosive coatings are very competitive and therefore would not support the price required for plasma spray coatings as represented by *Champagne*.

While *Champagne*'s invention references improved corrosion and adherence properties, it does not in any way discuss its use in a submerged marine environment for antifouling purposes. As stated earlier, a metallized coating must be formulated keeping in mind the reaction of the metal coating to the metal surface for the specific environment. *Champagne* does not offer resolution to these issues. My invention addresses these issues. Because my invention is able to achieve anti-fouling and corrosion control specifically, I believe my

invention is unique with respect to *Champagne*. In fact, the *Champagne* patent with the use of nickel and/or iron would be detrimental (i.e., cause corrosion) on some substrates in a submerged environment.

Champagne references the U.S. Navy's use of thermal spray aluminum for corrosion control. My invention uses a zinc-based alloy not aluminum. A review of the knowledge of the art based on my experience reveals that it is not typical to use zinc or zinc-alloys for a thermal spray coating in a submerged marine environment. Typically, an aluminum thermal spray coating is used. Zinc has a higher reactivity rate than aluminum and the reactivity of zinc is greatly increased in an electrolyte. Accordingly, zinc would be expected to be consume faster than aluminum in a marine environment. In the coatings industry, aluminum is understood to have a longer service life than zinc. Reference is made to "AWS Guide For The Protection Of Steel With Thermal Sprayed Coatings Of Aluminum And Zinc And Alloys And Composites" by the American Welding Society, AWS C2.18-93, Figure B1. In view of this understanding, it is the industry standard to use aluminum in an immersed marine environment because it will be consumed at a slower rate. As a result, the aluminum coating will last longer. Accordingly, my invention represents an unexpected development because it uses zinc or zinc-alloys to achieve anti-fouling, corrosion control, and cathodic protection.

Champagne states that

> "Zinc and zinc-aluminum alloys have been particularly successful in protecting large surfaces such as bridges in many countries. In this case, the coating is only used for aesthetic and corrosion control purposes. The adherence of these coatings is relatively low and they are thus unsuitable for use as bond coat." (See column 2, lines 4 to 11.)

It is common practice to use zinc on bridges for atmospheric corrosion control but not corrosion control of submerged structures. In previously cited reference, *Champagne* argues that zinc metallized coatings are not suitable as bond coats due to low adhesion rates. *Champagne* makes this statement because his invention is primarily concerned with creating a high bond strength coating for extreme environments in the "machine element repair industry" not an antifouling or corrosion control coating for submerged structures. In short, *Champagne*'s references to the prior use of zinc thermal sprayed coatings are negative, and *Champagne*'s invention only provides information about improving bond strengths for plasma spray coatings. In accordance with my invention, the electric-arc spray process and the procedures used as described therein achieve adhesion suitable for its design – anti-fouling and corrosion control in a submerged marine environment.

In summary, thermal spray coatings are used for a variety of different applications, and all of these applications are unique to the specific environment. One must be very careful not to assume that just because something works for one application that it can be taken into another environment and used with similar success. This is especially true for submerged marine applications, because there are specific and unique forces effecting a coating in this severe environment. While to one not trained in the art it may seem that these cited inventions are similar to my invention, one experienced in the industry understands that the use of metallized coatings requires a specific understanding of metallic coatings and their relationship to the environment in which the coatings are used. With the principles understood, the claims of my invention are recognized as being unique from the citations and explanations in the International Preliminary Examination in the following ways.

My invention is unique to the *Kuraray* invention, because my invention prevents fouling on a variety of substrates including metal, fiberglass, and concrete. *Kuraray* only claims to prevent fouling of textiles. *Kuraray* does not prevent corrosion and it cannot be assumed that it would. My invention solves the problems of corrosion of metallic systems and prevents corrosion.

My invention is unique to *Littauer* because *Littauer* 's invention requires an external power source. My invention does not need an external power source to be effective. My invention can be applied to a variety of surfaces whereas *Littauer* was designed only for steel hulls. My invention works on a variety of metal and non-metal surfaces.

My invention is unique to *Champagne* because my invention is designed to prevent fouling and corrosion of submerged surfaces. The *Champagne* invention does not claim to prevent fouling. While *Champagne* does state that the alloy could protect metal from aqueous corrosion, it does not claim to prevent corrosion of submerged surfaces. The *Champagne* invention uses a powder which is made specifically for plasma spray and to produce a strong bond coat. The preferred method of my invention is electric arc thermal spray for the primary purpose of antifouling.

Finally, I believe that the subject matter in my invention is not disclosed or suggested in any of the documents relied on in the International Preliminary Report.

My biographical information is attached hereto.

I hereby declare that all statements made herein are of my own knowledge and are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so

made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Edwin Y. Call

Date: 1/21/03

Based on Application No. 10/089,315

Edwin Y (Ted) Call is a co-founder of Aquatherm International and Power Spray Incorporated. He is President of Power Spray and Vice President of Aquatherm. He directs Aquatherm's operations and has been instrumental in developing the *Powerarc 1500*. Ted manages Power Spray's metallizing contracting business and provides program leadership for the Barnacle Blok division. His innovation and knowledge has led to the improvement of the Powerarc thermal spray device, the development of Barnacle Blok®, the implementation of Metallizing One-Stop™, and the creation of AquaCoat™ .

Ted is a proponent for improving and growing the metallizing industry. He is a founding member of several industry metallizing committees, including committees with the American Welding Society (AWS) and joint committees with AWS, the National Association of Corrosion Engineers (NACE), and the Society of Protective Coatings (SSPC). He was a leader in the effort to create the first nationally accepted quality standard for metallized coatings. Ted has been a featured speaker at numerous industry conferences over the last decade. He has given conference talks on non-slip coatings technology, the corrosion control of reinforced concrete, and the corrosion control of structural steel. He is Vice Chairman of the AWS committee on metallizing and is regularly consulted on innovations in the metallizing industry.

Prior to his work with Aquatherm and Power Spray, Ted worked for the Douglas Call Company (DCC). Starting in the early 1990's, Ted worked closely with Douglas Call, Jr. in managing DCC. In the early 1980's, Ted served as DCC's shop superintendent, field superintendent, and administrator. He managed the metallizing division from 1988 to 1993.

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